Eddy Processes in Western Boundary Currents

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LONG-TERM GOAL

I seek to understand the influence of the Gulf Stream, as well as other mid-latitude jets, on the surrounding ocean. The interrelations between meandering, radiation of low-frequency energy, and resulting mean flow generation are of particular interest.

OBJECTIVES

The guiding hypothesis is that the meandering of western boundary currents acts as a wavemaker in the ocean. The meanders are quite depth-independent and force mainly barotropic motions exterior to them. These motions propagate as low-frequency Rossby waves and those to the north of the stream eventually become topographic Rossby waves as they begin to feel the bottom topography. Their effects in the shallower water of the Continental Slope will be of particular interest in the future.

APPROACH

Data from an array of current meters, deployed in late summer of 1995 on the Continental Rise to the west of the Grand Banks, were investigated for evidence of topographic Rossby wave radiation. Three methods for determining the characteristics of the wave field were explored based on a hierarchy of methods ranging from the use of single instruments to horizontal arrays.

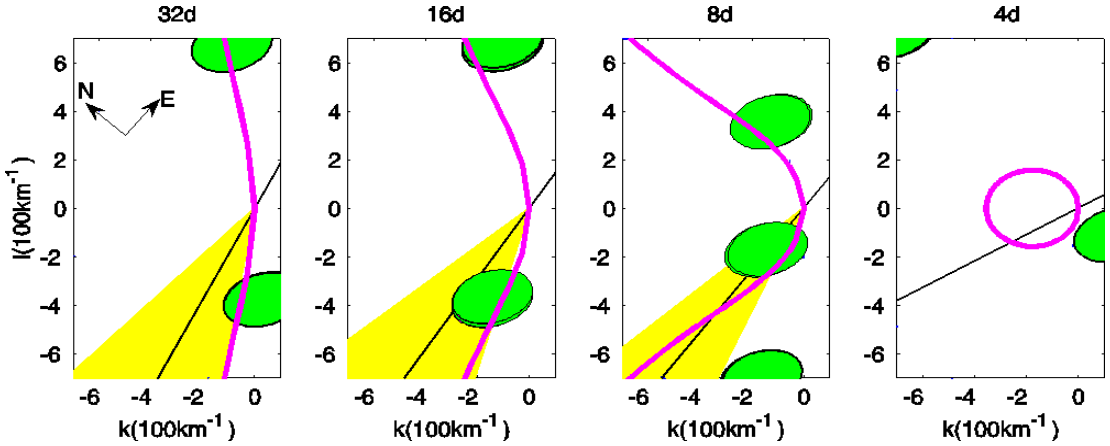
WORK COMPLETED

The analysis of the array data in the context of topographic Rossby waves has been completed and is now in press in the *Journal of Marine Research* (Hogg, 2000).

RESULTS

Eddy kinetic energy is, indeed, found to be higher to the west of the Grand Banks than elsewhere in the region but only at periods shorter than about 10 days. At longer periods energy in near-bottom motions is mainly a function of water depth and, surprisingly, is more or less independent of geographic position. The mechanism for enhancement of the higher frequency variability is unclear, but it does not appear to be related to the hypothesized coupling with eastward-traveling meanders.

Instead, it is more likely to be associated with forcing by transient motions of the Gulf Stream, which is able to excite a broadband response. This work has been accepted for publication (Hogg, 2000). An example of this analysis is given in the figure below. Here the Topographic Rossby Wave dispersion relation is given by the smooth (pink) curve at four different periods. Estimates of the wavenumber are shown using the orientation of the velocity variance ellipse (yellow cones) from single instruments and the alongshore and cross-slope phase differences between different moorings (green ellipses). Phase wrapping causes ambiguities and multiple solutions.



IMPACT/APPLICATION

We anticipate that the work with the current meter data set will give a better understanding of the origins of the energetic low-frequency motion field that is observed on the Continental Slope and Rise. These motions are a dominant part of the total energy in these regions.

REFERENCES

Nelson G. Hogg, 2000: Low-frequency variability on the western flanks of the Grand Banks, *Journal of Marine Research*, in press.

PUBLICATIONS

Nelson G. Hogg and W. Brechner Owens, 1999: Direct measurement of the deep circulation within the Brazil Basin, *Deep-Sea Research II*, **46**, 335–353.

Walter Zenk, Gerold Siedler, Bernd Lenz, and Nelson G. Hogg, 1999: Antarctic Bottom Water flow through the Hunter Channel, *Journal of Physical Oceanography*, **29**, 2785–2801.

Steven R. Jayne and Nelson G. Hogg, 1999: On recirculation forced by an unstable jet, *Journal of Physical Oceanography*, **29**, 2711–2718.

Nelson G. Hogg, 2000: Low-frequency variability on the western flanks of the Grand Banks, *Journal of Marine Research*, in press.

Nelson G. Hogg, 2000: Deep Circulation, Chapter 4.6 in *Ocean Circulation and Climate*, G. Siedler, J. Church, and W. J. Gould, editors, International Geophysics Series, Academic Press, in press.

Michele Y. Morris, Melinda M. Hall, Louis C. St. Laurent, and Nelson G. Hogg: Abyssal mixing in the Brazil Basin, *Journal of Physical Oceanography*, submitted.